DDF annual report

Title of Investigation:

System Initiatives for Lunar Surface Exploration

Principal Investigator:

Michael Comberiate (Code 592)

Other In-house Members of the Team:

Ed Cheung (Code 442), Jill Holv (Code 442), and Rich Fink (Code 442)

Initiation Year:

FY 2004

Other External Collaborators:

Michigan State University

Aggregate Amount of Funding Authorized in FY 2004 and Earlier Years:

Three Full-Time Equivalents (FTEs) for Civil Servants

Funding Authorized for FY 2005:

$0

Actual or Expected Expenditure of FY 2005 Funding:

$0

Status of Investigation at End of FY 2005:

To be continued in FY 2006

Expected Completion Date:

Ongoing

Purpose of Investigation:

The goal of this project is to continually upgrade our robotic test vehicles to support ground-based science data collection and to test out new technologies that can support our Space Exploration missions. In particular, we are looking for ways to give GSFC a competitive edge in

the lunar-surface reconnaissance mission by developing a robotic vehicle that can operate in the cryogenically cold and permanently dark polar craters on the Moon. We have created a pipeline to universities that are now and will be partnering with us on projects related to these upgrades. As summer interns, students start a project and then their university forms teams around that project to complete it for academic credits during the school year. Each summer we build on the projects completed in school.

Accomplishments to Date:

In late August 2004, this Office received a charge number for 3 years of civil-servant labor for the purpose of developing ways to test new technologies that could be applied to lunar surface exploration. In the process, we intended to develop robotic mechanisms that would enable our scientists to conduct research in remote and hostile environments. The mechanisms would be unattended but monitored and controlled via the Internet. Our approach was to use GSFC engineers as consultants and top-level designers, and have university engineering students provide most of the computer engineering work and whatever special projects we could negotiate. These student teams would get five academic credits each semester for completing projects.

In August, university engineering students completed a summer intern project, which is currently the basis for three accredited school projects at Michigan State University (MSU), in Senior Engineering and Computer Engineering. Three teams of six students are participating this semester and each student will receive five academic credits. The students start with a mobile, wheeled robotic platform that measures 2x2x1ft. It must be designed to handle the basic command, data handling and power distribution subsystems for operating remotely in a simulated lunar-surface exploration projects. Now, GSFC engineers operating under this DDF are building several technology demonstrations for this platform and deriving associated projects for the MSU students to complete with us as their customers.

The HST lead engineer and I&T manager are both assisting us on this project so we can produce a fair simulation of the capaciflector sensor and robotic arm docking system.

We have weekly telecons with the school and today they watched us via the Internet, just as they will be doing when we take the robot to Antarctica. Our engineers each described their area of expertise so that when the equipment arrives at MSU next week they'll be familiar with it.

Team 1 already is starting on the capaciflector circuitry and the robot arm kinematics. Led by the key summer intern, Team 3 has started working on improving the motor feedback to get more precise motion control. Team 2 is working on the pointing-platform control system and data handling for the spectrometer instrument. It also is working on the overall power subsystem.

Each semester since September 2004, teams of seniors in MSU's engineering department have worked on three projects related to the robotic vehicle, which initially was developed under a DDF grant. Fifty students already have received 5 academic credits each toward their engineering degree using these projects for their Capstone Design Coursework. As a result, the robotic vehicle is improved each semester. After graduation, students were funded to come to GSFC, along with a number of other undergraduates from various colleges (nine in all), to continue working on the robot during the summer of 2005. They developed a functioning vision-navigation and obstacle-avoidance system that they demonstrated to the DDF and IRAD committees and to the

GSFC Center Director and Deputy Center Director (Aug 1., 2005). They were selected to represent GSFC in the NBC-TV Technology Expo 2005 in late August 2005 and appeared live on NBC-TV. Three graduates were offered full-time jobs and are now working for NASA contractors. One graduate student summer intern was taken to Antarctica to work on a NASA Satellite Ground Station there. The robot itself also was taken to Antarctica in January 2005 and operated by remote control via the Internet from MSU through a secure NASA link.

The robot was returned to MSU in the Fall 2005 for an additional three projects involving 17 new seniors. Five of those seniors worked on the robot at GSFC over the semester break. Currently, another set of students is beginning to work on a follow-on project at MSU and others from this local area are improving the vision-navigation system software.

I am working with Code 450 in an attempt to create a graduate-level intern program for NASA-Wallops. This program would train graduate engineers from our academic teams to be trained at Wallops upon graduation. They would get hands-on experience with the NASA Ground Station at WOTS while going to graduate school part-time. Then, if they qualify, some would be sent to Antarctica after the Fall 2006 semester to man the NASA Ground Station there. It is difficult to find competent RF engineers to spend a winter isolated in Antarctica and this new program would address that concern.

Planned Future Work:

Students in the spring semester will attempt to: 1) automate the robotic-docking maneuver and navigate a boundary using the capaciflector sensors; and 2) develop a vision-navigation system for the mobile robot.

These projects will continue into the summer. We are looking for two college interns. This extension focuses on field-testing these two new capabilities and improving the automation software, given that the sensor technology and the tele-robotic operations have been proven as part of the previous curriculum projects.

Key Points Summary:

Our innovation is this new way to partner with universities for mutual benefit. Students are able to make serious contributions under the direction of our GSFC experts and we only pay for major parts. In the process, they learn, acquire mandatory academic credits, and get inspired to follow our lead because of the exciting nature of these projects. If we can keep this going through next spring, we will be working with the GSFC Education Office to set up a special university-level outreach program with NSF. Under this program, we would take a few students to Antarctica with us each year. Through this process, the interns work directly with GSFC engineers and employment opportunities arise via our graduate-study programs. Already, one our interns has been hired by GSFC Code 596, and we hope this trend will continue.